FIRST RESULTS OF A PETROGRAPHIC STUDY OF BRECCIAS FROM THE REGION OF THE UPPLAND STRUCTURE, SWEDEN. W. U. Reimold[1] and H. Henkel[2], [1]Department of Geology, University of the Witwatersrand, Private Bag 3, P.O. Wits 2050, Johannesburg, R.S.A.; [2]Department of Geodesy and Photogrammetry, Royal Institute of Technology, S-100 44 Stockholm, Sweden; e-mail: 065wur@cosmos.wits.ac.za, herbert@l.kth.se.

Summary: It has been proposed, on the basis of morphological and geophysical observations, that a large, > 300-km-diameter, impact structure, termed the Uppland Structure, is centered at approximately 60°N/17°E in Central Sweden. However, to date no unambiguous geological/mineralogical evidence for the existence of this alleged impact structure has been reported. To address this problem, we embarked on a comprehensive sampling tour of sites that had been described in the literature as extensive breccia occurrences. Detailed petrographic analyses of these breccias ensued. In some cases, it was possible to discard breccias as being of definite tectonic origin (cataclasites or mylonites). For other, including some polymict, breccias it has not been possible yet to prove or disprove a tectonic origin. However, none of our samples showed unambiguous evidence of impact diagnostic shock metamorphism. Nevertheless, a series of mafic to intermediate breccias, some of which texturally resemble known impact melt breccias of the Vredefort/Morokweng Granophyre type, has been identified. These rocks are characterised by a granitoid-derived clast population of crustal origin, and, in part, display rather felsic chemical compositions. Detailed trace element analysis of this sample suite is in progress.

Background: The Uppland Structure was first listed by Gluhkovsky and Pavlovsky [1] in a compilation of circular structures and was mentioned by Witschard [2] as a circular structure closely associated with the Bergslagen metallogenic province. Henkel and Lilljequist [3] modelled the gravity anomaly over the Uppland region and demonstrated that it included an interior gravity high, which is surrounded by a ring-shaped gravity low [also 4]. The central positive anomaly was modelled as an uplift, by 12 km, of deeper crustal material. In analogy to the geophysical expressions of other large terrestrial impact structures, these authors proposed that the Uppland Structure could represent the deeply eroded root zone of a very large impact structure. They further supported this hypothesis by reference to the many occurrences in this region of monomict and polymict clastic, as well as volcanite-like, breccias, which are well-known from the Swedish literature (especially of the Geological Survey of Sweden). The age of this alleged impact structure is thought to be loosely constrained by the 1.8 Ga age of the regional basement rocks and the approximately 1.5 Ga age of dolerite dykes, which appear to crosscut the Uppland Structure [5]. The circular Uppland Structure has a diameter of about 320 km and forms a 130° circular embayment into the batholith of the Transscandinavian granite and porphyry belt (compare Fig. 1).

This study: Multiple samples were collected at each of the sampling sites (Fig. 2). With the exception of site No. 34, those sites close to the Siljan structure probably, for geological reasons, represent pre-Siljan breccia occurrences. At most sites, "typical Scandinavian outcrop" conditions were encountered, with patchy, often scarce and lichen-covered, exposures. For the samples studied here it could, however, be ascertained that they all represent autochthonous bedrock. In some cases clear associations of breccias to local tectonic deformation zones could be established: for example, the Utö samples of pseudotachylite-like (further SEM work is required to resolve the true nature of these altered specimens) breccia were obtained in a large-scale shear zone, breccias from NW of the town of Sala (locality not shown in Fig. 2) turned out to be the product of boudinage caused by tight folding of narrow-banded, heterogeneous rocks composed of two rock types of very different competence, and the samples from site No. 25 (NE of Uppsala) occur in an, at least locally, strongly sheared terrane. The remaining samples macroscopically are monomict or polymict breccias, mainly of granitoid and/or volcanic porphyritic lithologies set into quartzitic matrices. Breccia formation as the result of acquisition of clasts from an older lithology by intrusive magma is suspected for the rocks from site No. 6-13 S of Stockholm. However, a suite of relatively mafic breccias (Nos. 4, 8, 11, 14, 17, 19, and, especially Nos. 27-29 from Likstammen) with abundant clasts of crustal origin (mainly of granitoid precursor rocks) and, in part, of granophyric texture (e.g., No. 28), are interesting, as initial chemical studies revealed highly variable compositions ranging, for example, from 50-67 wt% SiO_2. Whether this variability is the result of admixture of clasts or secondary alteration, or whether this has genetic implications, is the subject of a more in-depth trace element geochemical study already in progress. At this stage, it can not be excluded that all of these samples represent intrusive magmatic rocks, but additional studies are required to fully clarify their petrogenesis.

Thin sections, generally more than one per sample, were studied meticulously for evidence of shock metamorphism in quartz- and felspar-bearing clasts. Ubiquitous alteration and, in some cases, metamorphic overprint impose strong limitations on observation and interpretation. However, it must be concluded that, to date, no evidence of shock metamorphic deformation has been observed in any of these sections. Instead, the variety of observed microdeformation features, as well as the textures of breccia veinlets and patches, are consistent with relatively low strain-rate tectonic deformation. It is likely that many of these breccias represent cataclasites (one or two possibly friction melt), others, such as the 31 and 31A samples, are mylonites, of tectonic origin.

Conclusion: Our first petrographic studies have failed to provide any unambiguous field or petrographic evidence in support of the hypothesis that a large impact structure exists in the Uppland region of Sweden. However, several interesting samples have been identified, for which, at this stage, a possible origin as impact melt can not yet be excluded. Further chemical studies are required, and in progress, to resolve this aspect.

References: [1] Gluhkovsky M.Z. and Pavlovsky E.V., 1984, Proc. 27th Int. Geol. Congr., v. 19, 115-133. [2] Witschard F.,1984, Econ. Geol., 79, 1400-1405. [3] Henkel H. and Lilljequist R., 1992, in Large Meteorite Impacts and Planetary Evolution, Lunar Planet. Inst., Houston, Contrib. 790, 38-40. [4] Henkel H., 1992, Tectonophys., 216, 63-89. [5] Patchett P.J. et al., 1987, Precambr. Res., 35, 145-160.

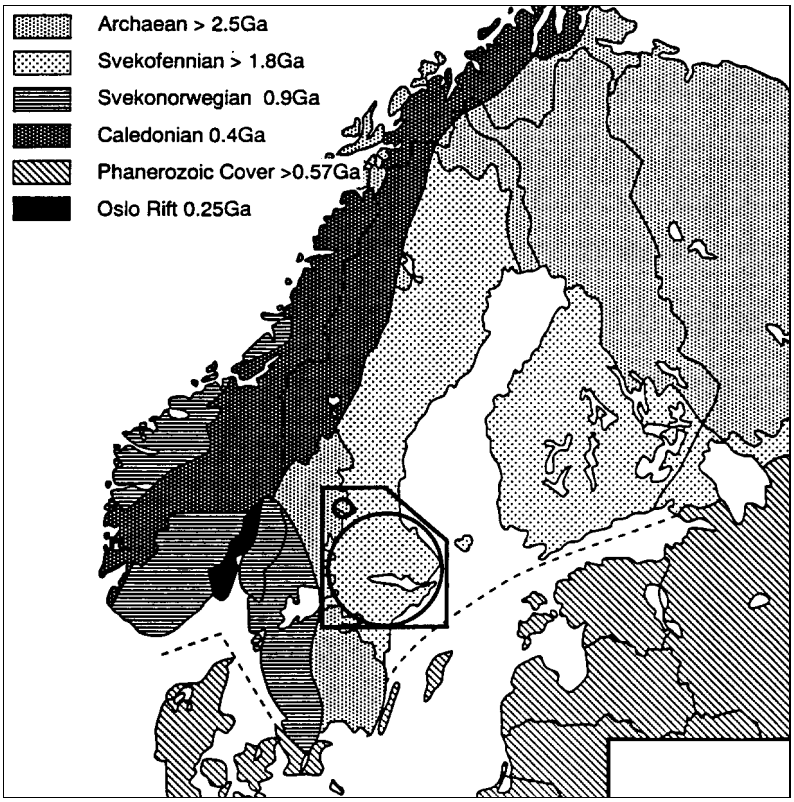

Fig. 1. Positions of the large Uppland Structure and the smaller Siljan impact structure in south-central Sweden. Box shows study area of Fig. 2.

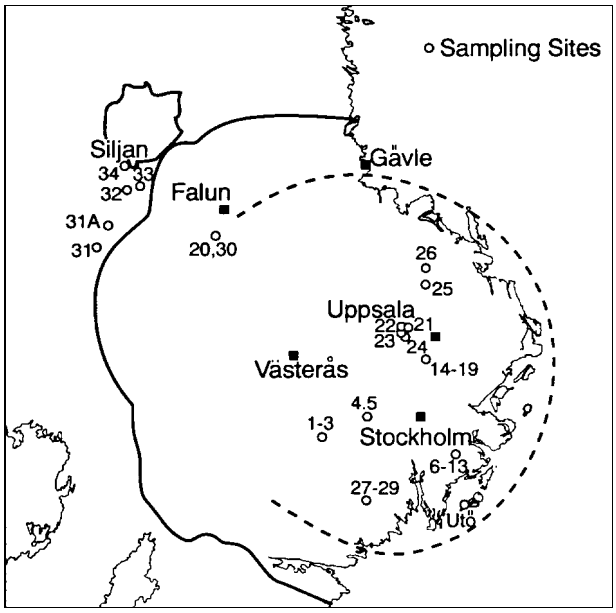

Fig. 2. Sampling sites for this study in and around of the Uppland Structure.